The 2nd International NorNet Users Meeting (NNUW-2)

The NorNet Core Testbed — Introduction and Status in August 2014

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Simula Research Laboratory

28 August 2014
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- Motivation
- Concepts
- Hardware
- Software
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- Conclusion
Overview:
Motivation

- Motivation
- Concepts
- Hardware
- Software
- Users and Research
- Conclusion
Goals of the NorNet Project

- Building up a **realistic** multi-homing testbed
- Wired and wireless
  - Wired → “NorNet Core”
  - Wireless → “NorNet Edge”
- Perform research with the testbed!

How to get a **realistic** testbed for NorNet Core?
Idea: Distribution of NorNet Core over whole Norway

- **Challenging topology:**
  - Large distances
  - A few “big” cities, many large rural areas
  - Svalbard:
    - Interesting location
    - Many polar research institutions

- **Deployment:**
  - 11 sites in Norway
  - 5 abroad: CN, DE (2x), SE, US
  - Some more to come ...
Overview:
Concepts

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Idea for NorNet Core: Tunnelling

- Researchers require control over used ISP interfaces
  - Which outgoing (local site) interface
  - Which incoming (remote site) interface

- Idea: Tunnels among sites
  - Router at site A: IPs $A_1$, $A_2$, $A_3$
  - Router at site B: IPs $B_1$, $B_2$
  - IP tunnel for each combination: $A_1 \leftrightarrow B_1$, $A_1 \leftrightarrow B_2$, $A_2 \leftrightarrow B_1$, $A_2 \leftrightarrow B_2$, $A_3 \leftrightarrow B_1$, $A_3 \leftrightarrow B_2$
  - Fully-connected tunnel mesh among NorNet Core sites
  - Each site's router (called tunnelbox) maintains the tunnels
    - Static tunnels
    - NorNet-internal addressing and routing over tunnels
Address Assignment

- NorNet-internal address spaces:
  - Private NorNet-internal IPv4 “/8” address space (NAT to outside)
  - Public NorNet-internal IPv6 “/48” address space

- Systematic address assignment:
  - IPv6: 2001:700:4100:<PP><SS>::<NN>/64
    (PP=Provider ID; SS=Site ID; NN=Node ID)

- NorNet-internal DNS setup including reverse lookup

Make it as easy as possible to keep the overview!
Tunnel Realisation

- **Generic Route Encapsulation (GRE) over IPv4**
  - IETF standard (RFC 2784) → should work in existing network
    - Particularly: firewalls, NAT or even **middleboxes**
    - 20+8 bytes overhead (using GRE key, but no seq. number and checksum)
    - MTU: 1472 bytes

- **IPv6 over IPv6**
  - Very simple, adds just another IPv6 header (40 bytes)
  - IPv6 is still “new”, no need to take care of any “grown infrastructure”
  - MTU: 1460 bytes

- **IPv6 in GRE over IPv4**
  - For all IPv6 relations without IPv6 support by ISPs on both sides

**Information on routes? Yes → talk by Forough Golkar**
Overview:
Hardware

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A usual NorNet Core site:

- 1x switch
- 4x server
  - 1x tunnelbox
  - 3x research systems
- At least two ISP connections
  - Uninett
  - Other providers
- IPv4 and IPv6 (if available)

Additional researcher-provided sites:

- Varying configurations
- VM setups, powerful servers, "retro-style" PCs ...
# Site Deployment Status (September 2013)

<table>
<thead>
<tr>
<th>No.</th>
<th>Site</th>
<th>ISP 1</th>
<th>ISP 2</th>
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<td>Uninett</td>
<td>Kvantel</td>
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<td>Universitetet i Oslo</td>
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<td>DFN</td>
<td>Versatel</td>
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</table>

- **IPv4 and IPv6**
- **IPv4 only (ISP without IPv6 support 😞)**
- **IPv4 only (site's network without IPv6 support)**

*There was a lot of work to do...*
# Site Deployment Status
(August 2014)

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- **IPv4 and IPv6**
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A significant progress!

https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html
Some Site Statistics
(August 2014)

Active Sites
Distinct ISPs of Active Sites
Distinct Countries of Active Sites
Total IPv4 Interfaces
Total IPv4 Tunnels
Total IPv6 Interfaces
Total IPv6 Tunnels
Inactive Sites

https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html
Next Steps for Deployment

• More IPv6 connectivity
  - RFC 2460 soon celebrates its 16th anniversary
  - Providers must support it, of course
  - May be ask sites for tunnel to site's IPv6 connection? (temporary fix until native connectivity is deployed in site's network)

• Some more ISPs
  - Diversity: cable TV, satellite, ...

• Some more sites
  - Hosted by interested researchers in other countries
    - What about your country?
Overview:
Software

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Remote Systems

Our servers may be really remote!

The “road” to Longyearbyen på Svalbard, 78.2°N
Virtualisation

- Experimentation software is experimental
- How to avoid software issues making a remote machine unusable?
- Idea: virtualisation
  - Lightweight, stable software setup: Ubuntu Server 12.04 LTS
  - VirtualBox 4.3
  - Other software runs in VirtualBox VMs:
    - Tunnelbox VM on physical server #1
    - 2 LXC-based research node VMs on physical servers #2 to #4
  - In case of problem: manual/automatic restart or reinstall of VM

“Anything that can go wrong, will go wrong.”
[Murphy's law]
**PlanetLab-based Software for Experiments**

- **Key idea:**
  - Researchers should get virtual machines for their experiments
  - Like *PlanetLab* …
  - … but with multi-homing and IPv6, of course
- **PlanetLab software:**
  - Different “stable” distributions: *PlanetLab*, *OneLab*, etc.
  - Current implementation: based on *Linux V Servers*
    - Not in mainline kernel
    - Patched kernel, makes upgrades difficult
  - The future: **Linux Containers** (LXC)
    - Active development by *PlanetLab/OneLab*
    - We are involved in developing and testing the LXC software
The LXC-based *PlanetLab/OneLab* Software

- Researchers get container (sliver) inside a Linux environment
- Same kernel, but slivers are separated from each other
- LXC uses *Open vSwitch*:
  - Slivers are connected to a virtual switch
  - Switch is bridged into real network
  - *Own IPv4/IPv6 addresses* for each sliver!
- Fedora Core 18 Linux environment inside the slivers

Details in the tutorial session tomorrow!
Development Status 2013

- Customised Ubuntu Server 12.04 LTS for physical machine installations

- Using *PlanetLab* LXC software distribution for research nodes
  - Based on Fedora Core 18
  - From upstream project's nightly builds at *OneLab*

- Extensions based on tags in PLC configuration
  - Python-based management scripts

- Custom additional software packages
  - NetPerfMeter, SubNetCalc, RSPLIB, tsctp, etc.
Development Status 2014

- **Customised “NorNet” distribution** of *PlanetLab*’s “LXC” distribution
  - Git forks of upstream *PlanetLab* LXC repositories
  - NorNet-customisations, including kernel with MPTCP support
  - Cooperation with *PlanetLab/OneLab* for development!

- **Own “build and test” infrastructure**
  - Build servers: *queenstown*, *arrowtown*, *cromwell* (to compile the full distributions “NorNet” and “LXC”)
  - Test master: *earnslaw* (for automated tests of the builds)
  - LXC test (for PLC): *wakatipu*
  - KVM test (for research nodes): *bjordammen*
  - Publication server: *benlomond*

- **Nightly builds of “NorNet” and “LXC”**: [http://benlomond.nntb.no/](http://benlomond.nntb.no/)
Next Steps for Development

- Research software refinements
  - Add NorNet features to PLC web interface

- VPN access to NorNet Core network
  - More convenient access (not just via SSH gateway or local switch)

- Other ideas
  - KVM-based virtualisation
  - OpenStack?
  - Direct support for booting custom kernels
  - Testbed federation

Let us discuss your ideas and suggestions!
Overview:
Users and Research

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Users and Research

“We already got some users!”

Examples:
- Shared Bottleneck Detection (UiO+Simula)
- VoIP Misuse Detection (UDE)
- Multi-Path Transport (Simula, UDE, UiO, HU, etc.)
- Balia Congestion Control (Bell Labs in South Korea)
- IPv4/IPv6 Performance Comparison (Simula)
- ...

“The road to hell is paved with unused testbeds.”
[James P. G. Sterbenz]

Next step: get even more users!

See https://www.nntb.no/projects/ for further projects using NorNet!
The “NorNet World Tour 2014”

- 01/2014: Centre for Advanced Internet Architectures (CAIA) at Swinburne University Melbourne, Victoria/Australia
- 05/2014: Polytechnic School of Engineering at New York University (NYU) Brooklyn, New York/U.S.A.
- 05/2014: University of British Columbia (UBC) Vancouver, British Columbia/Canada
- 09/2014: Kungliga Tekniska högskolan (KTH Royal Institute of Technology) Stockholm/Sweden
- 10/2014: Academy, Industry and Government of the Hainan Province Haikou, Hainan/China
- 10/2014: Tsinghua University [planned] Beijing/China
- 12/2014: NorNet demo presentation at the IEEE GLOBECOM Austin, Texas/U.S.A.

- 01/2015: … [planned]/Australia

Interested in a NorNet presentation? Just ask!
Collaborations

- **PlanetLab/OneLab**
  - Development and testing of the research software
  - URLs: https://www.planet-lab.org, https://www.onelab.eu

- **RIPE Atlas**
  - Connectivity and reachability measurements
  - URL: https://atlas.ripe.net
  - Node deployed at site in Longyearbyen

- **Seattle**
  - Open Peer-to-Peer Computing, project at NYU
  - URL: https://seattle.poly.edu
  - Running inside NorNet Core slice

- **ToMaTo**
  - Topology Management Tool
  - URL: http://tomato-lab.org
  - Part of the G-Lab testbed
You can use NorNet Core as well, of course!

Join our tutorial session! Here at the NNUW-2!

• Contents:
  - Get access to NorNet Core
  - User and slice management
  - Access to slices
  - Using and configuring slivers with own software
  - How to make use of multi-homing?
See https://simula.no/pams-2015!
Submission deadline: October 1, 2014

March 2015, Gwangju/South Korea
In conjunction with the 29th IEEE AINA
Overview:

Conclusion

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“NorNet wants to be a building block of the railroad to heaven” ...

... and not be another unused testbed that paves the road to hell!

- by thinking constantly about it
Any Questions?

Visit https://www.nntb.no for further information!